

The influence of potential biofuel cover crops on nitrous oxide (N₂O) emissions from Midwest row-crops

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OBJECTIVE and OVERVIEW

To quantify N₂O emissions response to the addition of potential biofuel cover-crops in conventionally managed annual row-crops.

- Nitrous oxide (N₂O) is the largest contributor to the greenhouse gas burden of cropping systems in the U.S.
- Perennializing annual crop systems through year-round soil cover can:
 - Reduce nutrient run-off and soil erosion.
 - Provide a cellulosic biofuel feedstock additional to the primary grain crop.
 - Provide climate stabilization through additional soil carbon storage and perhaps N₂O mitigation.
- Potential biofuel cover crops include grasses, legumes and Brassicas.
- There is little N₂O emissions data from cover crop systems.

EXPERIMENTAL SITE & DESIGN



Fig 1. Red clover and annual ryegrass cover crop mix over-seeded into corn.

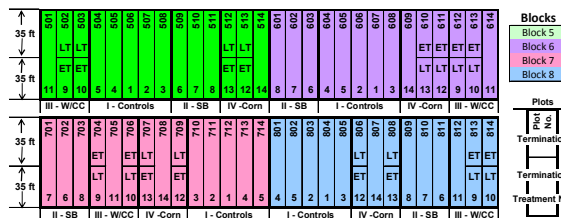


Fig 2. Experimental Randomized Split-Split Block (RSSB) design at KBS.

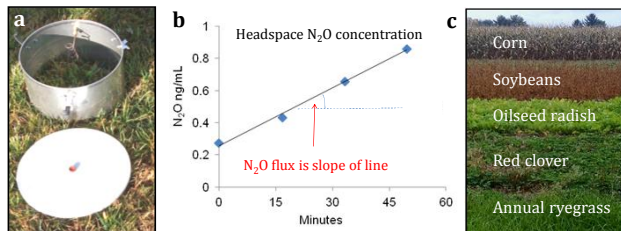


Fig 3. a) Chamber design, b) N₂O flux calculation, and c) cash and cover crops grown at the experimental site at Kellogg Biological Station.

METHODS & MANAGEMENT

Design: 3 crop phases, 3 cover crops, 4 blocks (Figs 1 & 2).
Annual Crop Rotations: Corn-Soybean-Wheat - all phases each year.
Biofuel Cover Crops: Grass - annual ryegrass, Legume - red clover, Brassica - oilseed radish (Fig 3).
Management: Synthetic N, Chisel plow, Herbicides, Pesticides.
 Independent according to common practice; timing based on growing season.
Gas Sampling: Management driven - ~40 days 2012-2014 (Fig 3).

RESULTS

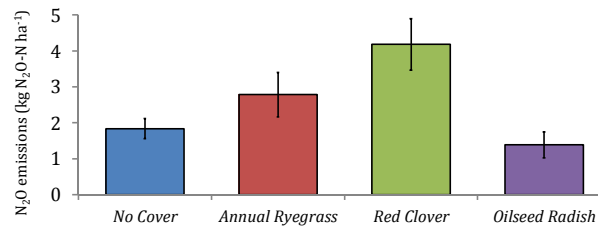


Fig 4. Average total N₂O emissions from no cover crop and cover crop treatments during the 2013 - 2014 flux measurement campaigns.

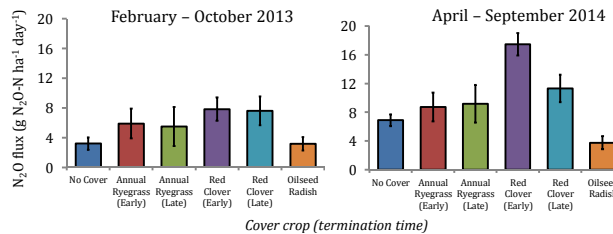


Fig 5. Average daily N₂O fluxes from no cover crop and cover crop treatments during the 2013 and 2014 flux measurement campaigns.



Fig 6. Average total N₂O emissions from annual crops with cover crops.

RESULTS (continued)

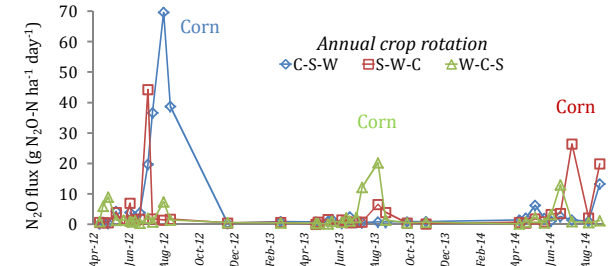


Fig 7. Daily N₂O fluxes from cash crops without cover crops (2012 - 2014).

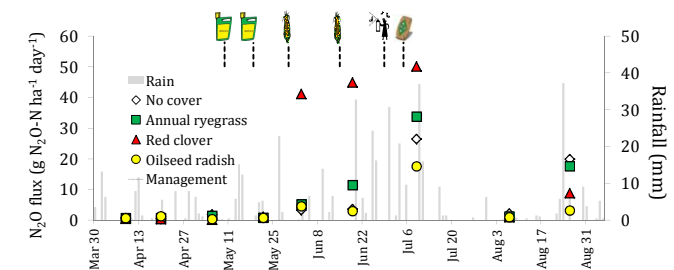


Fig 8. Daily N₂O fluxes from no cover crop and cover crop treatments showing management timing and rainfall patterns during 2014.

CONCLUSIONS

- Including potential biofuel cover crops in annual crop systems affected total N₂O emissions compared to their absence (Fig 4).
 - The red clover, and to a lesser extent annual ryegrass, increased total N₂O emissions, whereas the oilseed radish did not.
- Average daily N₂O emissions from biofuel cover crop treatments decreased in the order Legume > Grass > Brassica (Figs 4 & 5).
- Late cover crop termination time increased N₂O emissions in the red clover treatment, but not the annual ryegrass treatment (Fig 5).
- N₂O emissions were highest in corn (vs. wheat and soybean) in all years, irrespective of cover crop presence or absence (Figs 6 & 7).
- Highest N₂O fluxes occurred following fertilization, soil disturbance (annual crop planting and cover crop termination), and rainfall (Fig 8).
- Including Grass and Brassica cover crop species into annual crop rotations can provide additional biomass for biofuel conversion without much affect on soil N₂O emissions.**